Community Responses to Stormwater Pollution: Case Study Findings with Examples from the Midwest

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Stormwater runoff threatens the nation's waterways and public health, and costs Americans hundreds of millions of dollars each year. Concerns about urban runoff and interest in proposed new federal stormwater regulations prompted the Natural Resources Defense Council (NRDC) to document existing, effective stormwater strategies. Our report aims to encourage municipal action and empower communities to address this critical issue. More than 150 case studies from across the nation were compiled and evaluated to highlight effective pollution prevention, administrative, and financing strategies for addressing stormwater runoff. The case studies show, on a practical level, that stormwater management can be environmentally effective, economically advantageous, and politicallyfeasible. The reportalsoforms the foundation of a comprehensive outreach effort. Together, they help guide communities as they implement or improve stormwater management programs by providing detailed examples of proven tools and approaches used to prevent stormwater pollution. Collectively, the case studies offer an outline for further successful stormwater management strategies. Elements critical to the effectiveness of these programs include: a pollution prevention emphasis with structural treatment measures when needed; a focus on preserving natural features and processes; programs that inform and involve the public; a framework that creates and maintains accountability; a dedicated and equitable funding source to ensure long-term viability; strong leadership; and effective administration. These broad themes translate into a set of nine local actions for addressing the technical, social, and political issues associated with stormwater runoff. The case studies show that following these actions will help communities form a sound stormwater policy.

Key Terms: urban stormwater runoff, impervious surfaces, pollution prevention, best management practices, diffuse pollution, accountability.

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Introduction

Currently, there is substantial concern about the impacts of urban and suburban runoff. Pollution from diffuse sources, including urban stormwater, is the leading source of contamination in the nation's waters (U.S. Environmental Protection Agency, 1997a). Stormwater runoff pollution is a particularly important issue since most of the population of the United States lives in urban and coastal areas. Water resources in urban and coastal areas are highly vulnerable to and are often severely degraded by stormwater runoff. Specifically, urban and suburban runoff is the second most prevalent source of water quality impairment in the nation's estuaries after industrial discharges (U.S. Environmental Protection Agency, 1998b).

Economic impacts are an important aspect of this concern. Even a partial accounting shows that hundreds of millions of dollars are lost each year through added government expenditures, illness, or loss in economic output due to urban runoff pollution and damages (U.S. Environmental Protection Agency, 1998a). The ecological damage is also severe and is at least as significant. In particular, uncontrolled urban runoff contributes to hydrologic and habitat modification, two important sources of river impairment identified by the U.S. Environmental Protection Agency (EPA).

The polluted stormwater runoff problem has two main components: the increased volume and rate of runoff from impervious surfaces and the concentration of pollutants in the runoff. Both components are closely related to development in urban and urbanizing areas (Booth and Reinelt, 1993; Schueler, 1994; U.S. Environmental Protection Agency, 1997b). When impervious cover (roads, highways, parking lots, and roof tops) reaches between 10 and 20 percent of the area of a watershed, ecological stress becomes clearly apparent (Klein, 1979; Booth and Reinelt, 1993; Schueler, 1994). Everyday activities can deposit on these surfaces a coating of various harmful materials. When it rains or when snows melts, many of these pollutants are washed into receiving waters, often without any treatment.

The deposition of pollutants and the increased velocity and volume of runoff together cause dramatic changes in hydrology and water quality (Klein, 1979; Jones and Clark, 1987; Booth, 1990; Galli, 1990; U.S. Environmental Protection Agency, 1997b). These changes affect ecosystem functions, biological diversity, public health, recreation, economic activity, and general community well-being (Bannerman *ef al.,* 1993; Novotny and Olem, 1994; Haile *et al.,* 1996; Carpenter *et al.,* 1998). Urban stormwater is not alone in polluting the nation's waters. Industrial and agricultural runoff are often equal or greater contributors. But the environmental, aesthetic, and public health impacts of diffuse pollution will not be eliminated until urban stormwater pollution is controlled.

While urban and suburban runoff continues to be a critical issue, there is substantial evidence that the problems are not intractable. Increasingly, communities are recognizing the causes and consequences of uncontrolled urban runoff and taking action to control and prevent runoff pollution, often without any mandate. These innovative communities are realizing the environmental, economic, and social benefits of preventing stormwater pollution. However, neither the extent of these efforts nor the specific actions being taken have been well documented.

There is also a growing interest in proposed new federal stormwater regulations. Comprehensive stormwater regulation is required under Section 402(p) of the Clean Water Act. Since 1992, cities with populations over 100,000, certain industries, and construction sites over 5 acres have been required to develop and implement stormwater plans under Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater regulations (U.S. Environmental Protection Agency, 1990). In October 1999, EPA is expected to promulgate a new rule requiring municipalities with populations fewer than 100,000 people located in "urbanized areas" (where population density is greater than 1,000 persons per square mile) to develop stormwater plans. Under what is known as the "Phase II" rule, the EPA and states will develop "tool boxes" from which the smaller local governments can choose particular stormwater strategies to develop their stormwater plans (U.S. Environmental Protection Agency, 1998a).

To address all of these issues and concerns, the authors developed a study to examine, document, and disseminate information on environmentally effective and economically advantageous stormwater pollution prevention strategies. The study resulted in a report, *Stormwater Strategies: Community Responses fo Runoff Pollution,* that highlights some of the

most effective existing stormwater strategies from around the country (Lehner et *a/.,* 1999). The report provides substantial evidence that such programs exist and highlights a variety of innovative strategies actually being used. The report also aims to provide guidance to communities addressing stormwater issues, encourage municipal action, and help empower communities to be involved in this critical issue. This paper summarizes the study and presents its primary findings and recommendations.

Study Design and Approach

The study was exploratory in nature, with the intent of presenting information on existing effective stormwater management programs. To achieve this goal, we collected examples of environmentally beneficial and cost-effective stormwater programs from across the country. We compiled this information into the case-study-based report described above. This information and report have become the basis for a comprehensive outreach effort.

The first step was to gather information on programs and projects by examining existing programs (several begun under Phase I as well as many that started earlier), reviewing literature, contacting regional and local stormwater management experts and researchers, and interviewing representatives from stormwater management or other local government agencies. We gathered information on over 250 programs. The information was then examined in detail and narrowed down to a set of case studies that demonstrated elements of success. Three fundamental criteria for selection were used: environmental gains, economicadvantages, and community benefits. Environmental gains included biological, hydrological, or chemical improvements resulting from stormwater management. Economic advantages included cost savings to the municipality or developers, or increases in property values related to the pollution prevention measure. Community benefits included aesthetic or recreational enhancement, administrative or institutional successes, or community relations improvements.

Seventy-seven programs and projects were selected as case studies for the final report. Another 88 programs were annotated to provide additional programs/locations not fully evaluated for the report. The case studies represent communities of all sizes, types, and regions throughout the United States. To help ensure accuracy, local experts or people familiar with the program, called "groundtruthers," were contacted to review the case studies and add information from their own knowledge and experience.

The case studies were first organized geographically by dividing the United States into six regions based in part on general rainfall patterns. Within each of the regions, case studies were then further subdivided into five categories of stormwater management measures including, (1) addressing stormwater in new development and redevelopment, (2) promoting public education and participation, (3) controlling construction site runoff, (4) detecting and eliminating improper or illegal connections and discharges, (5) and implementing pollution prevention for municipal operations. These categories roughly parallel those measures that large municipalities address under existing Federal regulations (40 CFR parts 122.26 and 123.25) and small municipalities will address under pending Federal regulations (U.S. Environmental Protection Agency, 1998a).

Case Study Findings

Through reporting over 150 examples of actual programs, the full report provides substantial evidence that stormwater pollution can be reduced or prevented with proper planning and implementation in growing or re-developing areas. The examples presented in the report also demonstrate that if some communities can measurably and cost-effectively reduce stormwater pollution, so can other communities and states (Lehner, et al., 1999).

The Five Categories of Stormwater Management Measures

Individually, the case studies provide detailed examples of substantial water quality improvement, effective or innovative stormwater control strategies to protect the natural environment, significant cost-savings, and important ancillary benefits to the community. The programs and strategies highlighted come from communities of all sizes, types,

and regions. They include efforts by municipal agencies, developers, and community groups. In many cases, several of these groups worked together to create win-win outcomes. The case studies highlight a variety of strategies for addressing the five categories of stormwater management measures previously enumerated, and are described in more detail as follows.

Addressing Sformwaferin New *Development and Redevelopment.* By far the most important category of stormwater strategies focuses on land use and development. It encompasses a wide range of measures including regional or watershed planning, buffers and open space preservation, infill development, conservation design, and the use of site-specific structural and nonstructural treatment measures. One of the best strategies a municipality or developer can employ is to minimize the aggregate amount of new impervious surfaces. For example, developers of the Prairie Crossing project in Grayslake, Illinois, prevented runoff pollution and saved money by using conservation design strategies. The developers first reduced impervious cover by clustering 317 residences on only 132 acres of the site, which left 80 percent as open space. They then designed the developed area around a natural drainage system consisting of vegetated swales, restored prairie, and wetlands. Modeling indicates that this stormwater treatment drain system will remove approximately 85% of nutrients, metals, and suspended sediments and reduce peak flows by 68%. Eliminating curbs and gutters resulted in savings of $1.6 to $2.7 million. The development is also very appealing to homebuyers, with sales comparable to or better than conventional developments in the area (see Lehner *et al., 1999,* p. 224).

Promoting Public Education and Participation. Individuals play a key role in reducing stormwater impacts both in their own day-to-day activities and in showing support for municipal programs and ordinances. The most successful highlighted programs accomplished three goals: they educated the public about the nature of the problem, they informed the people about what they can do to solve the problem, and they involved citizens in hands-on activities to achieve pollutant reduction or restoration targets. One example of this success is in Minneapolis, Minnesota, where a decline in water quality motivated the Lake Harriet Watershed Awareness Project. Monitoring revealed that lawn-care chemicals were a significant contributor to the problem, which suggested focused education efforts. In turn, the project developed two approaches: a volunteer master gardener program and the distribution of educational materials. Evaluation showed that 67% of watershed residents reported using the information presented and 30% reported a change in behavior. As a result, concentrations of lawn-care pesticides have dropped by 50% or more since the program began (see Lehner *et al.,* 1999, p. 231).

Controlling Construction Site Runoff. The case studies demonstrate that effective construction site pollution prevention is politically and economically feasible and can dramatically reduce pollution. The most effective programs rest on four cornerstones laid in pairs: enforcement and education; erosion prevention and sediment control. However, the first and over-arching necessity is a clear set of requirements. For example, Herzog *et a/.* (1998) found that in Geauga County, Ohio, and St. Joseph County, Indiana, aggressive, widespread seeding and mulching reduced construction site erosion by up to 86% and reduced phosphorus loadings by 80%. These measures can also benefit developers financially. They found that homebuyers perceive these “green” lots to be worth $750 more than comparable “brown” lots (see Lehner *et a/.,* 1999, p. 236). While existing programs employ a wide variety of erosion and sediment control practices, virtually all successful strategies require proper planning and phasing of construction activities to minimize land disturbance.

Defecting and Eliminafing Improper or Illegal Connections and Discharges. Local governments have found that identifying and eliminating illicit connections and discharges is a remarkably simple and cost-effective way to address some of the worst stormwater pollution. The case studies show that two factors are critical to success of this element of stormwater programs: finding illicit connections and discharges, and enforcement. In Washtenaw County, Michigan, the Huron River Pollution Abatement project resulted in a 75% reduction in the river’s fecal coliform levels in just 4 years. The project focused on eliminating existing illicit connections and preventing future incidents through chemical storage surveys, industrial inspections, water-quality monitoring, public education, and complaint and spill response. Over a six-year period, the program dye-tested more than 3,800 facilities, after which 328 of the 450 illicit connections found were removed (see Lehner *et al.,* 1999, p. 239).

Implementing Pollution Prevention for Municipal Operations. A wide range of municipal operations can affect stormwater quantity and quality. The case studies reveal that some local governments have been able to manage their municipal operations to reduce stormwater pollution. The municipalities highlighted have done so in a variety of ways including reducing the use of harmful chemicals in the maintenance of municipal properties and vehicles, improving the maintenance and cleaning of roads and stormwater infrastructure, and training staff in pollution prevention practices. Several municipalities have taken these steps at their golf courses. For example, the Village Links Golf Course in Glen Ellyn, Illinois, is preventing runoff pollution by incorporating integrated pest management, water conservation, stormwater detention, native planting, recycling, and public outreach into its day-to-day management. The golf course relies on both mechanical and biological pest controls and has significantly increased natural areas. The course collects runoff from nearby streets and neighborhoods in its system of ponds and spillways. These ponds provide approximately 60% of the course's irrigation water, and the course itself passively treats and filters all excess runoff from irrigation (see Lehner *et a/.,* 1999, p. 243).

Themes Common to Success Stories

Collectively, over 150 case studies present a clear model for success. Evaluation of the case studies revealed several common elements among the highlighted programs. We distilled those elements into the seven broad themes listed below to help guide communities as they develop or improve stormwater programs. Since they are based on actual programs, these themes form a solid foundation for successful programs.

Preventing pollution is high/y effective and saves money. Pollution prevention measures dramatically and cost-effectively reduce the quantity and concentration of pollutants "winding up" in stormwater. Common pollution prevention measures include reducing or eliminating the use of harmful products, preventing erosion, reducing the amount of pavement in new developments, and changing maintenance practices. In highly urbanized areas, however, such measures may be difficult. In such cases, several communities have found treatment of runoff with structural measures or retrofitting existing structures to be effective alternatives.

Preserving and utilizing natural features andprocesses have many benefits. Many communities and developers have found strategies that rely on natural processes to be highly effective and economically advantageous. Undeveloped landscapes absorb large quantities of rainfall and snowmelt and vegetation helps to filter out pollutants from stormwater. Buffer zones, conservation-designed development, sensitive area protection, or encouragement of infill development all enhance natural processes.

Educafingandinforming the general public and municipal staff improves program effectiveness. Providing information and training to the general public and local businesses is a key component to many of the highlighted programs. Since many sources of stormwater pollution are derived from individual activities such as driving and maintaining homes, educating the public goes a long way to reducing stormwater pollution. Several communities involve the public in civic activities, such as monitoring water quality or stenciling storm drains, which not only provide educational opportunities but also save the municipality money.

Strong incentives, routine moniforing, and consisfenf enforcement establish accountability. Enforcement, or more broadly accountability, is a key element to improving water quality. All actors need a clear statement of performance goals, and they need to be held accountable by others for accomplishing these goals. We found that programs with high accountability were the most effective, often achieving pollutant reductions of 50% or greater.

Financial stability helps ensure effective programs. Effective stormwater programs are financially viable and affordable. Dedicated funding sources, such as stormwater utilities or environmental fees are equitable ways to build stability into stormwater programs. Stability and equity are also important in gaining public support. Nearly 200 communities across the nation are already realizing the benefits of implementing stormwater utilities as dedicated and equitable funding sources.

Strong leadership is often a catalyst for success. Success, at least initially, often requires an individual to champion the project and make it happen.

Effective administration is critical. Regardless of which strategies a community chooses, those programs with clear goals and objectives are the most successful. Such clarity enhances accountability, responsibility, and trust. Furthermore, an established and understood institutional framework often improves administration by fostering collaboration among different parts and levels of government, neighboring communities, and local citizens. Effective administration allows implementation of broad-based, multi-faceted programs, which are often the most effective at controlling the diffuse problem of stormwater pollution.

Authors' Recommendations for Local Action

To further guide communities addressing stormwater runoff issues, we translated the broad themes presented above into an action plan based on nine key recommendations. These actions roughly parallel the broad themes presented above. The case studies demonstrated that following the nine local actions outlined below will help build a strong framework for effective, efficient, and successful stormwater management over the long term.

1) *P/an in advance and set clear goals.* Carefully plan programs, as opposed to simply reacting to provided opportunities, crises, or transient pressures. Planning allows development of more effective and cost-effective actions. An essential outcome of planning is addressing the issues and concerns of all stakeholders involved.

2) *Encourage and facilitate broadparficipation.* Program planning, development, and implementation should involve multiple levels of government, key members of the community, and professionals from a variety of related disciplines. A key to success is the public's understanding of the issue, how it relates to them, and what they can do about it.

3) *Promote public education opportunities.* Implement broad-based programs that reach a range of audiences and solicit different levels of public involvement. Remain committed to the education program and take advantage of existing community organizations to enhance participation.

4) *Work to prevent pollution first; rely on structural treatment on/y when necessary.* Focus on prevention-based approaches, through regional and watershed planning, local zoning ordinances, preservation of natural areas, stormwater-sensitive site design, and erosion prevention as these are significantly more effective than treatment of polluted runoff.

5) *Establish and maintain accountability.* Essential components of this process are setting clear standards, creating strong incentives and disincentives, conducting routine monitoring and inspections, keeping the public informed, promoting public availability of stormwater plans and permits, and consistently enforcing laws and regulations. Strong enforcement is often key to significant water quality improvements.

6) *Secure financial resources.* Consider establishing a dedicated funding source such as a stormwater utility. Combine with it budget-saving measures such as creative staffing, public-public and public-private collaboration, and building off existing programs.

7) *Tailor strategies to the region and setting.* Recognizing that every case will be different, consider strategies that are particularly tailored to the region, the specific audience, and the problem.

8) *Evaluate and allow for evolution ofprograms.* Set clear goals and priorities, and allow programs to develop over time. Establish clear ways to check and see that goals and objectives are being met. This opens opportunities for improvements and helps ensure long-term success.

9) *Recognize the importance of associated community benefits.* Stormwater pollution prevention measures usually offer ancillary quality-of-life benefits in addition to targeted improvements. For example, preserved areas offer parks, ponds offer beauty and habitat, clean streets are more attractive, education helps empower people, and sediment control improves fisheries and prevents flooding.

Conclusion

Many fine handbooks provide theoretical and technical guidance concerning the design and implementation of effective stormwater pollution prevention and control measures. This study took a different approach and focused on existing effective programs in a variety of settings. In doing so, it accomplished two key goals. First, the study demonstrates that stormwater management is quite possible. The case studies show on a practical level that stormwater management can be environmentally effective, economically advantageous, and politically feasible. Second, the case studies enable communities developing or improving stormwater programs to learn from their peers. In doing so, the case studies offer an outline for future successful stormwater management strategies.

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